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DETECTING COPIED IDENTITY OF TERMINAL EQUIPMENT**BACKGROUND OF THE INVENTION**

The invention relates to mobile systems and especially to detecting, in a mobile system, the use of a terminal whose equipment identity has been
5 copied.

In many mobile systems, subscribers and terminal equipment have not been bound together in a fixed manner, but they use subscriber-specific identity modules and individual equipment identities to distinguish terminal equipment from each other. The identity module used to identify the
10 subscriber, such as the SIM card (subscriber identity module) used in the pan-European digital cellular radio system GSM (Global System for Mobile Communications), is a smart card attached to the terminal, allowing the subscriber to use the terminal and containing information for identifying the subscriber, for instance. An example of such an identity module is the IMSI
15 (international mobile subscriber identity) used in the GSM system and comprising a mobile station country code, a mobile network identity and a subscriber identity.

The mobile station MS shown in Figure 1 comprises terminal equipment TE and a 1-2 smart card SIM attachable to the terminal equipment.
20 In the GSM system, an IMEI (international mobile equipment identity) identifying the equipment is typically stored in the programmable memory of the terminal equipment, e.g. in the EEPROM (electrically erasable programmable read only memory), during the manufacture of the terminal. The IMEI comprises a type approval code, a final assembly code and a serial
25 number.

Mobile networks contain a facility in which the equipment identity of a terminal is checked to ensure that the terminal in question is not stolen, for instance, or that the use of the terminal equipment does not cause interference in the mobile network. The equipment identity can, for instance,
30 be requested when the terminal equipment has set up a connection to a mobile switching centre or is performing a location update. After this, the equipment identity is compared with the equipment identities in the EIR (equipment identity register) or elsewhere in the mobile system, and on the basis of the comparison, the use of the terminal equipment is either prevented
35 or allowed.

Prior art with respect to equipment identification is described in the publication WO96/36194 "*Checking the Access Right of a Subscriber Equipment*". In it, when a terminal registers into a mobile system, the system acquires the information related to the subscriber. At the same time, the mobile station also transmits its own equipment identity to the mobile system. After this, the equipment identity transmitted by the mobile station is compared with the equipment identities allowed for the subscriber identity transmitted by said mobile station and stored in the home database and if the equipment identity transmitted by said mobile station is found among the equipment identities allowed for said subscriber identity, the operation of the mobile station continues normally. Otherwise, the use of the mobile station is prevented.

Even though in the above publication, the validity of the operation of the mobile station is checked by comparing the equipment identity transmitted by the mobile station with the identity or identities allowed for the subscriber in question in the home database, a problem with the arrangement described in said publication is that it does not check whether there is more than one mobile station registered into the mobile system with the same terminal equipment identity. Neither does the arrangement described in the publication check the subscriber identities of mobile stations which are registered at the same time with the same equipment identity. The prior art presented in the publication thus cannot detect mobile stations whose equipment identities have been copied.

The equipment identity IMEI of the mobile station MS shown in Figure 1 can be cloned, i.e. copied, during manufacture, for instance. In such a case, an equipment identity already in use is programmed into the memory of what is known as null-IMEI equipment (terminal equipment with no equipment identity stored in its memory as yet). After this, the terminals in question cannot be distinguished from each other, since their identities are identical.

This programming can also be done after the terminal equipment has received its individual equipment identity. In such a case, the equipment identity of a stolen terminal, for instance, is deleted from the programmable memory of the terminal with ultraviolet light and a new equipment identity is programmed in place of the old equipment identity.

BRIEF DESCRIPTION OF THE INVENTION

It is an object of the invention to develop a method and an apparatus implementing the method so as to solve the above-mentioned problem. The object of the invention is achieved by a method and apparatus
5 characterized by what is stated in the independent claims. Preferred embodiments of the invention are set forth in the dependent claims.

The invention is based on the idea that in the method, information on the equipment identities IMEI of the terminal equipment of mobile stations already registered into the system and on the subscriber identities IMSI is
10 maintained in a database of the network infrastructure, a first comparison is performed by checking whether the equipment identity transmitted by the mobile station to the network infrastructure exists among the equipment identities already in said database, and if it exists, another comparison is performed to see whether the mobile station has the same subscriber identity
15 as the mobile stations having said identical equipment identity in the network infrastructure database, and if it has, the operation of the mobile station is continued. If the subscriber identities of the second comparison are not identical, at least a signal is produced to indicate a possibly copied equipment identity. These comparisons can be performed when a mobile station registers
20 into a mobile system, for instance, and/or during a location update between switching centres.

The method and system of the invention provide the advantage that it is possible to detect the use of a mobile station having a copied equipment identity. This provides the further advantage that an operator can take
25 measures against such terminal equipment without the measures affecting the operation of other mobile stations.

In a preferred embodiment of the invention, the use of a mobile station having a copied equipment identity is prevented. This provides the further advantage that the mobile station can be immediately shut down.

30 In another preferred embodiment of the invention, an equipment identity is stored individually in a home location register HLR instead of the equipment identity register EIR. This provides the advantage that the equipment identity IMEI can be checked quicker than when the equipment identity is stored in the equipment identity register.

BRIEF DESCRIPTION OF THE FIGURES

In the following, the invention will be described in greater detail by means of preferred embodiments and with reference to the attached drawings in which

5 Figure 1 shows a mobile station comprising terminal equipment and a subscriber identity module,

 Figure 2A shows mobile stations and an IMSI/IMEI pair database they form,

 Figure 2B shows an IMSI/IMEI database formed by mobile stations,
10 in which one record contains one or more subscriber and equipment identities,

 Figure 2C is a block diagram of a mobile system in which only one mobile station is registered,

 Figure 3A is a signalling diagram of the operation of the method and mobile system of an embodiment,

15 Figure 3B is a signalling diagram of an IMSI check in a home location register,

 Figure 3C is a signalling diagram of a prevention/alarm facility in a home location register.

DETAILED DESCRIPTION OF THE INVENTION

20 In the following, the invention will be described using the GSM system as an example, but the invention can also be applied to systems derived from the GSM system, such as DCS1800 (Digital Communication System) and PCN (Personal Communication Network), and in other systems, such as third-generation mobile systems according to the TETRA (Trans-
25 European Trunked Radio) standards being currently developed, in the UMTS system (Universal Mobile Telecommunications System), for instance.

 Figure 2A shows mobile stations and a database of IMSI/IMEI pairs formed by them. Mobile stations already registered into a mobile system are referred to as MS1, MS2 and MS3 having corresponding individual equipment
30 identities IMEI1, IMEI2 and IMEI3 and corresponding individual subscriber identities IMSI1, IMSI2 and IMSI3. MS4 is a new mobile station trying to register into the network. Its subscriber identity is IMSI4 and equipment identity is IMEI3, i.e. the same as that of the mobile station MS3 which has registered earlier.

The mobile station MS4 can when registering into the network, for instance, or when the network separately requests it, transmit its subscriber identity and equipment identity to the system. The system, however, notices that the equipment identity of MS4 is the same as that of a mobile station already registered and accepted into the system, namely MS3. As a result of this, the subscriber identities of the mobile stations are compared with each other. Because the IMSI check shows that the subscriber identities (IMSI) are not identical, operation of the mobile station MS4 trying to register is limited, or at least a signal is produced to indicate that the equipment identity is possibly a copied one.

The subscriber identities and equipment identities in Figure 2A can be associated with each other to form a database 2A-4. Then, the subscriber identities IMSI1, IMSI2, IMSI3 and IMSI4 of the mobile stations MS1, MS2, MS3 and MS4 are associated with the corresponding equipment identities IMEI1, IMEI2, IMEI3 and IMEI3, and each subscriber identity-equipment identity pair forms one record (T1 to T4).

In third-generation mobile systems, for instance, one record can, if necessary, contain several subscriber and equipment identities. Figure 2B shows an IMSI/IMEI database formed by mobile stations, in which one record (T5 to T8) contains one or more subscriber and equipment identities. In Figure 2B, corresponding individual equipment identities (IMEI1A, IMEI1B, IMEI1C), (IMEI2A, IMEI2B, IMEI2C), (IMEI3A, IMEI3B, IMEI3C) and (IMEI3C) and corresponding individual subscriber identities (IMSI1A, IMSI1B), (IMSI2A, IMSI2B), (IMSI3A, IMSI3B) and (IMSI4A, IMSI4B) are associated with the mobile stations (MS1), (MS2), (MS3) and (MS4).

The present solution differs from the prior art solution by the fact that the equipment identities can also be compared with each other in addition to checking whether the IMEI in question is allowed for the subscriber identity in question. This makes it possible to detect copied equipment identities. Figure 2C shows two cells C1, C2 and the border 2C-2 between them. In this example, both cells have their own mobile services switching centre MSC1 and MSC2 and their own visitor location register VLR1 and VLR2 connected to the switching centres.

In the situation in Figure 2C, a mobile station MSx registered into the system moves 2C-4 across the border 2C-2 of said cells. Then, visitor location registers of both cells may receive information on the subscriber

identity and equipment identity of the mobile station in question when the mobile station updates its location. The subscriber identity in question need, however, not be the same subscriber identity as that with which the comparison is made. In GSM networks, for instance, a subscriber identity
5 transmitted across the radio path can be a TMSI (temporary mobile subscriber identity), but the comparison is made with the IMSI (international mobile subscriber identity) corresponding to the TMSI. Since the subscriber identity and the equipment identity are now identical, the operation of the mobile station moving in the area of said two adjacent cells is not limited.

10 Figure 3A shows a signalling diagram of the operation of the method and mobile system of an embodiment of the invention. In the figure, MSC/VLR, in short VMSC (visited mobile switching centre), illustrates the switching centre and its visitor location register. HLR/EIR illustrates the home location register of the mobile station and the equipment identity register,
15 which in this example are connected to each other. For clarity's sake, the signalling diagram does not show the entire call set-up, subscriber identification, subscriber parameter request or the release of signalling in detail. Neither does the signalling diagram show the effect of the above facilities on a base transceiver station BTS or base station controller BSC. A
20 more detailed description of the facilities can be found in the standard GSM0902.doc, version 4.17.1., Figures 16.1.1/1 to 16.1.1/3.

In step 3-2, the mobile station transmits a location update request to the switching centre/visitor location register VMSC in the cell where the mobile station is. After this, the VMSC asks in step 3-4 the mobile station to transmit
25 its equipment identity. The transmission may either be encrypted or unencrypted. As state above, the subscriber identity being transmitted can be a temporary one (TMSI) or a permanent one (IMSI). In step 3-6, the mobile station transmits its own equipment identity to the VMSC. In step 3-8, the VMSC transmits the equipment identity received from the mobile station to the
30 EIR and requests the status of the equipment identity in question, i.e. information on whether restrictions are set on the operation of the mobile station in question.

The GSM system equipment identity register EIR contains lists of terminal equipment identities: a white list on equipment allowed in the system,
35 a black list on forbidden equipment and a grey list on equipment that are to be monitored by the system. In step 3-10, the EIR sends to the VMSC the status

of the mobile station, i.e. information on which list the mobile station belongs to.

The EIR or a part of it may physically be located in the HLR or in some other mobile switching centre MSC. If the EIR is in the HLR, the IMEI check is faster, since the IMEI is already stored in the HLR and need not be
5 fetched from a separate EIR.

In step 3-12, the VMSC checks the status of the mobile station received from the EIR. If the mobile station is on the white list, its operation is continued normally and in addition to the normal location update information,
10 the equipment identity IMEI of the mobile station is transmitted to the home location register in step 3-20. If the mobile station is on the black or the grey list, its operation can, for instance, be limited or prevented in step 3-16. The mobile station can also be on the list of unknowns, if the EIR cannot identify its terminal equipment. In this case, too, the operation of the mobile station can
15 be limited in step 3-16.

The signalling between the visitor location register and the home location register is done by means of a mobile application part MAP connection in an SS#7 signalling network according to the GSM specification, for instance.

20 In step 3-26, the routine checks from the database 2A-4, 2B-1 in the HLR whether the mobile station that just requested a location update has the same equipment identity as another mobile station in the database. If two mobile stations having the same equipment identity are not found, the location update information is transmitted in step 3-28 to the visitor location register and the operation of the mobile station is continued normally in step 3-30.
25

Figure 3B shows a signalling diagram of an IMSI check in the home location register. If in step 3-26, at least two mobile stations having the same equipment identity are found, a further check is made in step 3-32 to see whether said mobile stations have the same subscriber identity. If the mobile
30 stations having the same equipment identity also have identical subscriber identities, the location update information is transmitted in step 3-34 to the visitor location register, and the operation of the mobile station is continued normally in step 3-36. The mobile stations are then still on the white list.

If the mobile stations having the same equipment identity do not
35 have identical subscriber identities, the operation of said mobile station requesting location updating can be limited: the location update may be

prevented or an alarm may be given in step 3-38 to the VMSC, after which the operation of the mobile station may be prevented in step 3-40. These steps are described as the signalling diagram showing the prevention/alarm facility in Figure 3C. It is also possible to transmit information to the EIR on the current, 5 checked status of the equipment identity in question, after which the mobile station can be listed on the grey list for monitoring its operation, or on the black list for preventing its operation. The HLR can also maintain its own black list on equipment identities under monitoring.

10 It is obvious to a person skilled in the art that while technology advances, the basic idea of the invention can be implemented in many different ways. The invention and its embodiments are thus not limited to the examples described above, but can also vary within the scope of the claims.

CLAIMS

1. A method for detecting a copied international mobile equipment identity (IMEI1 to IMEI_x) in a mobile system in which at least one international mobile subscriber identity (IMSI1 to IMSI_x) and a mobile equipment identity (IMEI1 to IMEI_x) is associated with a mobile station (MS1 to MS_x),
5 **characterized** in that the method comprises the following steps:

(i) creating a database (2A-4, 2B-1) containing records (T1 to T4, T5 to T8) which each contain a mobile equipment identity (IMEI1 to IMEI_x) associated with a mobile station and at least one mobile subscriber identity (IMSI1 to
10 IMSI4),

(ii) the mobile station (MS1 to MS4) transmitting the mobile equipment identity (IMEI1 to IMEI_x) associated with the mobile station and at least one mobile subscriber identity (IMSI1 to IMSI4),

(iii) checking (3-26, 3-32) whether there is a record (T1 to T4, T5 to T8) in
15 the database (2A-4, 2B-1), which contains a mobile equipment identity corresponding to the mobile equipment identity transmitted by the mobile station, but whose mobile subscriber identity does not correspond to the mobile subscriber identity the mobile station has transmitted, and if yes, producing at least a signal (3-38) indicating that the mobile equipment identity
20 is possibly a copied one.

2. A method as claimed in claim 1, **characterized** in that if the database (2A-4, 2B-1) contains a record (T1 to T4, T5 to T8) which contains a mobile equipment identity corresponding to the mobile equipment identity transmitted by the mobile station, but whose mobile subscriber identity does
25 not correspond to that transmitted by the mobile station, the operation of the mobile station is prevented.

3. A method as claimed in claim 1 or 2, **characterized** in that step (iii) is performed when the mobile station registers into the mobile system.

4. A method as claimed in any one of the preceding claims,
30 **characterized** in that step (iii) is performed when the mobile station updates its location.

5. A method as claimed in any one of the preceding claims, **characterized** in that step (iii) is performed at predefined intervals.

6. A method as claimed in claim 1, **characterized** in that the
35 database (2A-4, 2B-1) is created in the home location register (HLR).

7. A mobile system comprising

means for receiving an international mobile equipment identity (IMEI1 to IMEI_x) and at least one international mobile subscriber identity (IMSI1 to IMSI_x) from at least one mobile station (MS1 to MS_x),

- 5 **characterized** in that the mobile system also comprises
a database (2A-4, 2B-1) containing records (T1 to T4, T5 to T8),
each containing a mobile equipment identity (IMEI1 to IMEI_x) associated with
a mobile station and at least one mobile subscriber identity (IMSI1 to IMSI_x),

- 10 first means for checking whether the database (2A-4, 2B-1)
contains a record (T1 to T4, T5 to T8) which contains a mobile equipment
identity corresponding to the mobile equipment identity transmitted by the
mobile station, but whose mobile subscriber identity does not correspond to
that transmitted by the mobile station, and

- 15 second means responsive to the first means to produce a signal (3-
38) indicating that the mobile equipment identity is possibly a copied one.

8. A mobile system as claimed in claim 7, **characterized** in
that the mobile system comprises means responsive to the first means for
preventing the use of the mobile station.

- 20 9. An element of a mobile network, which comprises a database
(2A-4, 2B-1), **characterized** in that it contains records (T1 to T4, T5 to
T8), each containing an international mobile equipment identity (IMEI1 to
IMEI_x) associated with a mobile station and at least one international mobile
subscriber identity (IMSI1 to IMSI₄).

1/3

FIG. 1
(Prior Art)

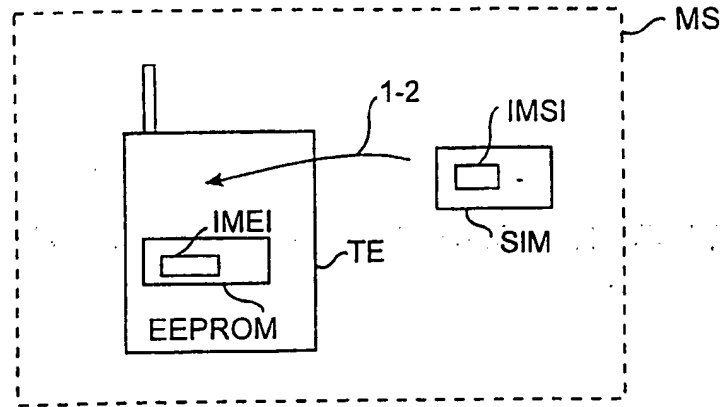


FIG. 2A

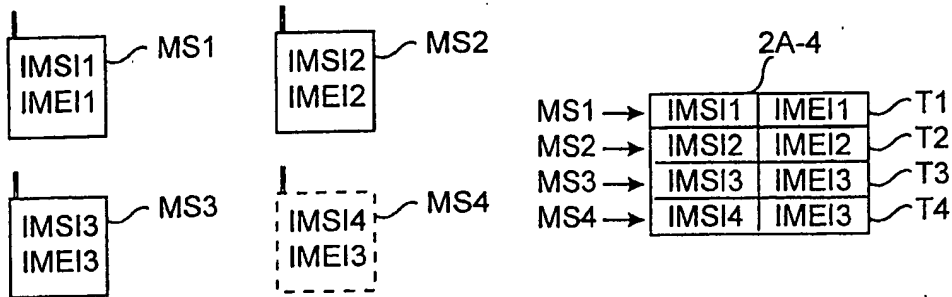


FIG. 2C

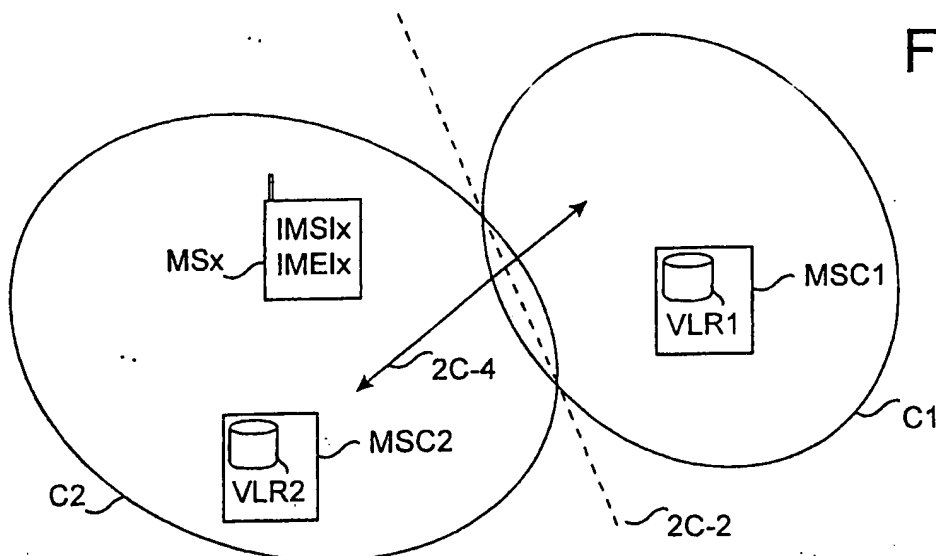


FIG. 2B

2B-1

MS1 →	IMSI1A	IMSI1B	IMEI1A	IMEI1B	IMEI1C	T5
MS2 →	IMSI2A	IMSI2B	IMEI2A	IMEI2B	IMEI2C	T6
MS3 →	IMSI3A	IMSI3B	IMEI3A	IMEI3B	IMEI3C	T7
MS4 →	IMSI4A	IMSI4B	IMEI3C	-	-	T8

FIG. 3A

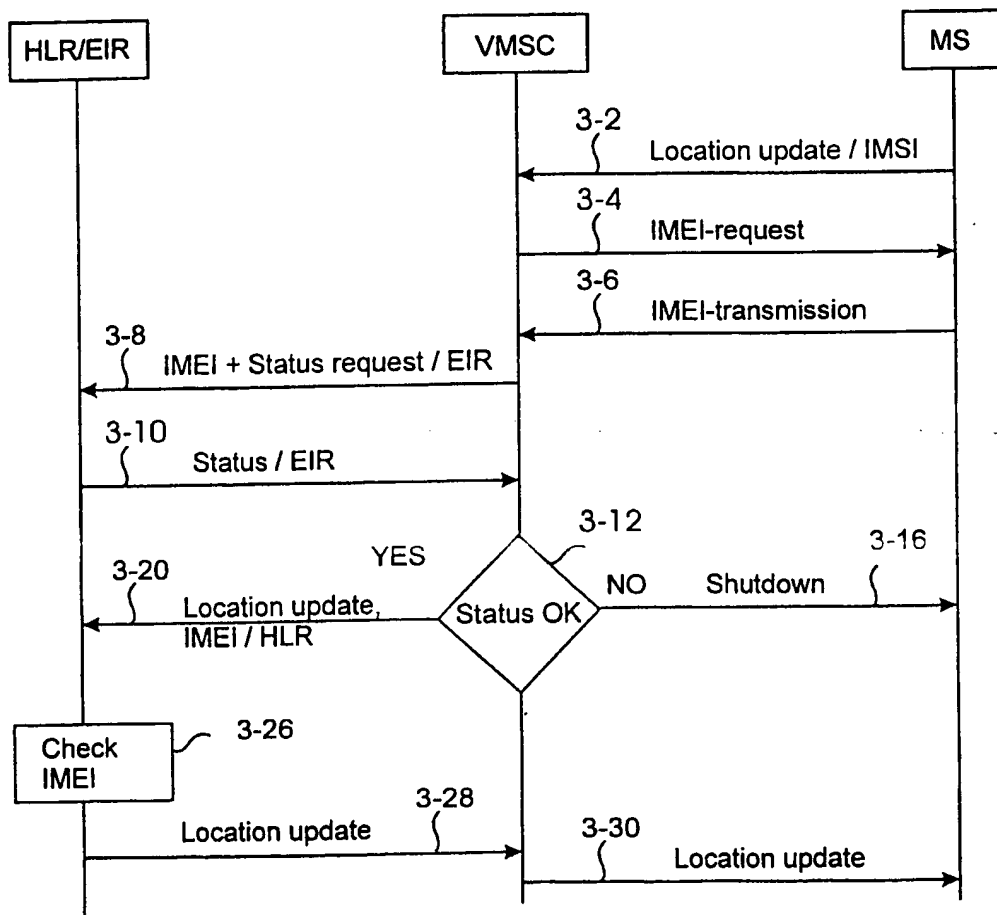


FIG. 3B

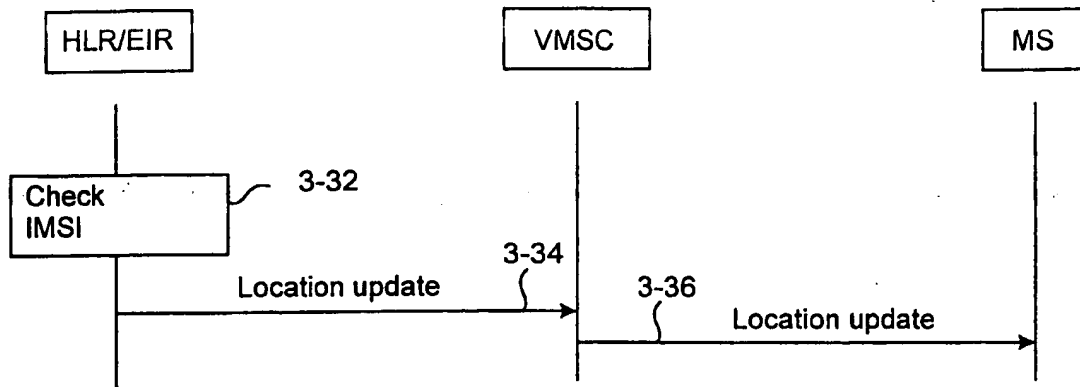
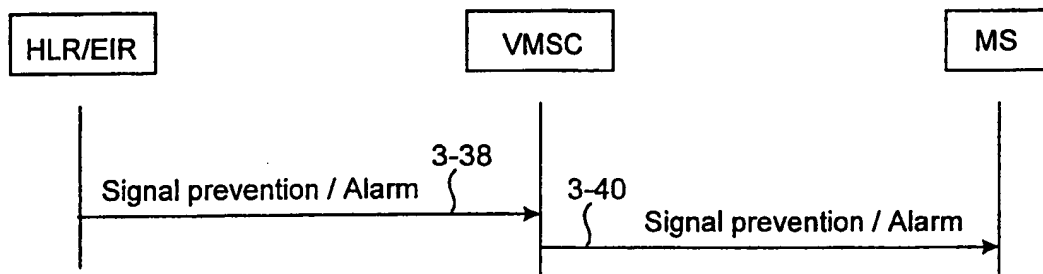


FIG. 3C



INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 00/00531

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04Q 7/32, H04Q 7/38

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 9812891 A1 (NOKIA TELECOMMUNICATIONS OY), 26 March 1998 (26.03.98), abstract, claims --	1-9
X	WO 9859514 A2 (NOKIA TELECOMMUNIKATIONS OY), 30 December 1998 (30.12.98), claims 2,5,7,9, abstract --	1-9
X	WO 9636194 A1 (NOKIA TELECOMMUNICATIONS OY), 14 November 1996 (14.11.96), abstract, claims --	1-9

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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Name and mailing address of the ISA/
Swedish Patent Office
Box 5055, S-102 42 STOCKHOLM
Facsimile No. +46 8 666 02 86

Authorized officer

Tomas Lund/MP
Telephone No. +46 8 782 25 00